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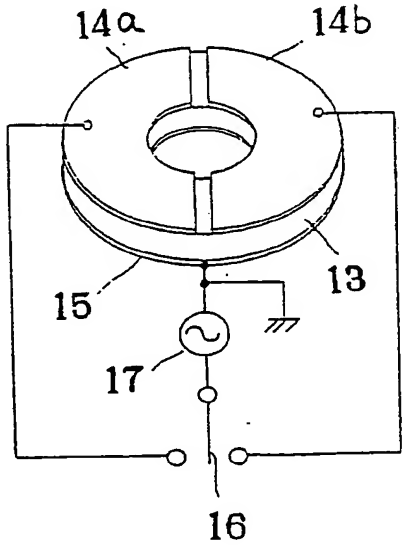
(54) An ultrasonic driving device.

(57) A stator is composed by two metal blocks, a piezoelectric vibrator and vibrators, and two electrodes, in which one electrode is divided in two at least, the metal blocks, the piezoelectric vibrator or vibrators and two electrodes are fixed by means of a bolt or means of adhesive thing, and a member to be driven composed on the nut or the end or side portion of the stator.

Fig. 5



EP 0 299 415 A2

Background of the Invention:

The present invention relates to an ultrasonic driving device comprising a stator using a ring type piezoelectric vibrator or vibrators and metal blocks.

In a known ultrasonic motor using a piezoelectric vibrator, two groups of electrodes are attached to one side of a ring type piezoelectric ceramic, the two group of electrodes are so positioned that standing waves respectively generated by the two groups of electrodes are sifted every $\pi.2$ in each position. The parts of the ring type piezoelectric vibrator corresponding to the electrode are alternately polarized in reverse. Also, the two groups of the electrodes are respectively connected to two oscillators for respectively generating alternating current voltages having π 2 phase shift each other. When the alternating current voltages from the two oscillators are respectively applied to the two groups of electrodes, the two standing waves having π 2 phase shift each other generate on the surfaces of the ring type piezoelectric vibrator and then progressive waves owing to an compound of the two standing waves generate on the surfaces of the ring type piezoelectric vibrator. Therefore, when a rotary member is put on the ring type piezoelectric vibrator and the rotary member is strongly pressed to the ring type piezoelectric vibrator, the rotary member is rotated by the progressive waves.

In the prior ultrasonic motor, since the the ring type piezoelectric vibrator must be polarized in the many portion thereof and the two oscillators must be connected to the electrodes, the composition of the ring type piezoelectric vibrator is complex and the cost of the ultrasonic motor becomes expensive.

There is known a ultrasonic motor comprising a Langevin type vibrator having two ring type piezoelectric vibrator puting between two metal blocks. In this ultrasonic motor, a twisting joint body is connected to the end of the one metal block by a bolt for fixing the metal blocks and the piezoelectric vibrator and a rotary member is pressed on the twisting joint body by a spring.

However, the composition of the ultrasonic motor is complex and its cost becomes expensive.

Summary of the Invention:

It is, therefore, the primary object of the present invention to provide an ultrasonic driving device having a simple composition.

It is the another object of the present invention to provide an ultrasonic driving device having two divided electrodes for driving a member to be driven to one way or the another way.

It is the another object of the present invention to provide an ultrasonic driving device for driving a member to be driven by rotary progression wave generating on end side portions according to the expantion and contraction of a piezoelectric vibrator or vibrators.

In order to accomplish the above and other object, the present invention provides a stator comprising two metal blocks, a piezoelectric vibrator or vibrators and two electrodes, one electrode being divided in two at least, which are put between two metal blocks, and a bolt for fixing the metal blocks, the piezoelectric vibrator or vibrators and two electrodes by means of screws of the both sides of the metal blocks, and a member to be driven composed on the end or side portion of the stator.

Brief Description of the Drawings:

Fig.1 shows a sectional view of an ultrasonic motor in the prior art.

Fig.2 shows a plane view of a form of a piezoelectric vibrator and a composition of electrodes of the piezoelectric vibrator in the ultrasonic motor in Fig. 1.

Fig.3 shows a separated perspective view of the stator of an ultrasonic motor in the other prior art.

Fig.4 shows a side view having a partial sectional view of an ultrasonic motor in the prior art of Fig.3.

Fig.5 shows a perspective view of a piezoelectric vibrator and electrodes according to the present invention.

Fig.6 shows a plane view of a piezoelectric vibrator and electrodes in Fig.5.

Fig.7 shows a perspective view of a stator according to the present invention.

Fig.8 shows a separated perspective view of piezoelectric vibrators and electrodes of the stator in Fig 7.

Figs.9 shows a side view of the stator in Fig.7.

Fig.10 shows a separated perspective view of one portion of a stator in the other embodiment according to the present invention.

Fig.11 shows a perspective view of a piezoelectric vibrator and electrodes for explaining a principle of the generation of rotative vibration in the stator in Fig.10.

Fig.12 shows a separated perspective view of one portion of a stator in the other embodiment according to the present invention.

Fig.13 shows a side view of an ultrasonic driving device according to the present invention.

Fig.14 a perspective view of piezoelectric vibrators and electrodes of the stator in Fig.13.

Figs.15 (a) shows a side view of stator in Fig.13. Figs.15 (b) shows wave form of longitudinal vibration. Figs.15 (c) shows wave form of torsional vibration.

Fig.16 shows a side view of ultrasonic driving device of another embodiment in the present invention.

Fig.17 shows a side view of a stator of another embodiment in the present invention.

Fig.18 shows a side view of an ultrasonic driving devise of another embodiment in the present invention.

Fig.19 shows a perspective view of piezoelectric vibrators and electrodes of the stator in Fig.18.

Fig.20 shows a side view of an ultrasonic driving devise of another embodiment of the present invention.

Fig.21 shows a side view of an ultrasonic driving devise of another embodiment of the present invention.

Description of the Preferred Embodiments:

Referring to the prior art in Fig.1, a ring type piezoelectric vibrator B is attached to a ring type resilient member A and the piezoelectric vibrator B vibrates with the resilient member. The piezoelectric vibrator B is divided in 17 parts by the ratio of e.g. 22.5° or 11.25°. The respective neighbouring portions in the 17 parts of the piezoelectric vibrator B are polarized by the reverse polarity each other as shown in Fig. 2. The two portions C and D in the one side of the piezoelectric vibrator B are respectively attached as an electrode by conductive paint as shown in Fig.2. The portion G in Fig.2 shows an earth electrode. The member F to be driven to which slider E is attached is mounted on the resilient member A.

In the ultrasonic motor in the prior art, the alternating current voltage of $V_0 \sin\omega t$ is applied to the one electrode C and the alternating current voltage $V_0 \cos\omega t$ is applied to the other electrode D, where V_c is instantaneous value, ω is radian frequency and t is time. The phases of these voltages shift by $\pi/2$ each other. Thereby, the divided portions of the piezoelectric vibrator B alternately arise expantion and contraction and thus, the resilient member A arises bending vibration. Therefore, standing wave is generated in the resilient member A and progressive wave is generated on the resilient member A. Thus, the driven member F having the slider E is rotated on the resilient member A.

However, in the prior ultrasonic motor, because the divided portions of the ring type piezoelectric vibrator B must be alternately polarized and the divided electrodes must be formed on the divided portion of the piezoelectric vibrator B, the composition of the prior ultrasonic motor is complex.

Referring the prior art in Fig.3, a piezoelectric vibrator 3, a terminal plate 4, a piezoelectric vibrator 5, a terminal plate 6 and an aluminum disk 7 are put on a washer 1 and a bolt 2 is inserted to the center holes of these members. The screw 2a of the bolt 2 is engaged with the screw hole 8a of a twisting joint body 8. A drain 8b is formed on the under surface of the twisting joint body 8, an arcuate projections 8c are formed in the both sides of drain 8b and a beam 8d is so formed in the upper portion of the twisting joint body 8 that an angle between the beam 8d and drain 8b becomes a predetermined value.

In this prior ultrasonic driving device, when alternating current voltage is applied through the terminal plates 4 and 6 to the piezoelectric vibrators 3 and 5 and the piezoelectric vibrators 3 and 5 are vibrated to the direction of these thickness, the arcuate projections 8c of the twisting joint body 8 are pushed and twisted by the vibration of the piezoelectric vibrators 3 and 5. Therefore, the twisting joint body 8 is vibrated to be twisted. When the excitation frequency of the alternating current voltage approaches a resonance frequency, elliptic vibration arises on the beam 8d of the twisting joint body 8.

Therefore, as shown in Fig.4, a rotary member 9 is put on the twisting joint body 8, a center bolt 10 passed through a bearing 11 of the rotary member 9 fixes the twisting joint body 8, and a spring 12 is attached between the upper end of the bolt 10 and the bearing 11, whereby the rotary member 9 is strongly touched on the beam 8d of the twisting joint body 8 and is rotated by the elliptic vibration on the beam 8d.

However, in the prior ultrasonic motor, the composition of the twisting joint body 8 is complex and strong torque cannot be obtained by the composition of the ultrasonic motor.

Referring fo Fig.5, a ring type piezoelectric vibrators 13 of piezoelectric ceramics and so on is put between a pair of electrodes 14a and 14b divided in two and an electrode 15. The points of contact of a switch 16 are connected to the elec-

trodes 14a and 14b and the movable contact of switch 16 is connected to one terminal of alternating current power supply 17 and the other terminal of the alternating current power supply 17 connected to the electrode 15 with the ground.

When the switch 16 is connected to the electrode 14a and alternating current voltage is applied from the alternating current power supply 17 to the electrode 14a, a progressive wave as shown by the arrow A generates in the end portion and side portion of the piezoelectric vibrator 13. Also, When the switch 16 is connected to the electrode 14a, a progressive wave as shown by the arrow B generates in the end portion and side portion of the piezoelectric vibrator 13.

Explaining the principle for generating the progressive wave in the piezoelectric vibrator 13, when the one side portion of the piezoelectric vibrator 13 is driven by supplying the voltage, the voltage generates in the other side portion of the piezoelectric vibrator 13 according to the expantion and contraction in the one side portion of the piezoelectric vibrator 13. The phase of the voltage generated in the other side portion is later than that of the voltage supplied to the one side portion. Therefore, the expantion and contraction partly generate in the piezoelectric vibrator 13 and the progressive waves in the arrows A and B generate in the end portion and side portion.

Referring to Fig.7, Fig.8 and Fig.9, piezoelectric vibrators 20 and 21 of ceramics vibrator and so on are put between two metal blocks 18 and 19, electrodes 22 and 23 are put between the metal block 18 and the piezoelectric vibrator 20 and the piezoelectric vibrators 20 and 21, and a bolt 24 is passed through the center holes of the piezoelectric vibrators 20 and 21 and the electrodes 22 and 23 and the both side screws 24a and 24b of the bolt 24 are inserted into the screws 18a and 19a of the metal blocks 18 and 19 and the metal blocks 18 and 19 are fixed. The electrode 23 between the piezoelectric vibrators 20 and 21 is divided in two and a gap 25 is formed between these divided electrodes 23a and 23b. A stator 26 is formed by these composition.

In the ultrasonic driving device of this embodiment, when the alternative current voltage is applied to one of the terminals 23c and 23d and the electrode 22, one side portion of the piezoelectric vibrators 20 and 21 vibrates to its thickness direction and vibrates to its radius direction according to the thickness direction. When torsional vibration generated according to the longitude-directional vibration and the radius-directional vibration is transmitted to the two metal blocks 18 and 19, the progressive wave generates in the end portion and the side portion of the stator 26. A member to be driven composed to the end portion and side portion of the stator 26 is driven by the progressive wave.

Referring to Fig.10, a stator 26 having one piezoelectric vibrator 20 and electrodes 22 and 23 divided in two and gaps 25 and 27 between the respective divided electrodes 22a and 22b and 23a and 23b of the electrodes 22 and 23 are shifted by 90° each other. Insulation members 28 and 29 are put between the electrodes 22 and 23 and the metal blocks 18 and 19 and are protected from a electric conduction.

In the ultrasonic driving device composed as the above, when the alternative current voltage is applied to the electrodes 22b and 23b, the alternative current voltage is obliquely applied to the piezoelectric vibrator 20 as shown in an arrow A of Fig.11, the piezoelectric vibrator 20 generates torsional vibration by the thickness vibration and the radius vibration and the torsional vibration is amplified by the metal blocks 18 and 19. When the alternative current voltage is applied between the electrodes 22b and 23b, compound vibration of the longitudinal vibration and torsional vibration is generated by the torsional vibration of the arrow A in Fig.11 and the progressive wave(the arrow B of Fig.10) generates in the end portion and the side portion of the stator 26 by the compound vibration. When the alternative current voltage is applied to the electrodes 22a and 23b, the progressive wave generates in the direction of the arrow B in Fig.10. When the alternative current voltage is applied to the electrodes 22a and 23a, the progressive wave generates in the direction of the arrow C in Fig.10. When the alternative current voltage is applied to the electrodes 22b and 23a, the progressive wave generates in the direction of the arrow B in Fig.10.

when the member to be driven is composed with the stator 26, the member is rotated.

Referring to Fig.12, two piezoelectric vibrators 20 and 21 are put between the electrodes 22, 23 and 24 respectively and the electrodes 22, 23 and 30 are respectively divided in two. The gap 28 between the electrode 22a and 22b is shifted by 90° to the gap 27 between the electrodes 22a and 23a. The gap 31 between the electrodes 30a and 30b is formed in the same direction of the gap 28 of the electrodes 22a and 22b. Insulation members 28 and 29 are put between the electrode 22 and the metal block 18 and the electrode 30 and the metal block 19.

In the embodiment composed as shown in the above, the progressive wave generated by applying the alternative current voltage to the electrodes 22a, 30a and 23a is reversed to that generated by applying the alternative current voltage to the electrodes 22a, 30a and 23b. The progressive wave generated by applying the alternative current voltage to the electrodes 22b, 30b and 23a is reversed

to that generated by applying the alternative current voltage to the electrodes 22b, 30b and 23b.

In the above embodiment, the gap 25 between the electrodes 22a and 22b, the gap 27 between the electrodes 22a and 22b and the gap 31 between the electrodes 30a and 30b are shifted by 90° each other, but the shifts between the gaps 25, 27 and 28 may be less than 90°. In the above embodiment, though the metal blocks 18 and 19 are same as each other, the metal blocks 18 and 19 may be asymmetric each other.

Referring to Fig.13, an ultrasonic driving devise according to the present invention comprises metal blocks 18 and 19, two piezoelectric vibrators 20 and 21 and divided electrodes 22a and 22b(see Fig.14) and electrode 23. The male screw 24b of the bolt 24 is engaged the female screw of the metal block 19. The bolt 24 is passed through the center holes of the piezoelectric vibrator 20 and 21, the electrode 23 and metal block 18 and the male screw 24a of the bolt 24 is engaged by a nut 32, whereby a stator 26 is composed. The divided electrodes 22a and 22b are connected to the contacts 16a and 16b and the alternative current voltage supply 17 is connected between the movable contact of the switch 16 and the electrode 23 connected to the ground.

In the embodiment, when the alternative current voltage is applied to the divided electrode 22a and the electrode 23 by connecting the movable contact 16c to the contact 16a, the progressive wave is arisen on the end and side portions of the metal blocks 18 and 19, the end and side portions of the nut 32 and the side portions of the piezoelectric vibrators 20 and 21 as shown by the arrow A. When the alternative current voltage is applied to the divided electrode 22b and the electrode 23 by connecting the movable contact 16c to the contact 16b, the progressive wave is arisen on the end and side portions of the metal blocks 18 and 19, the end and side portions of the nut 32, and the side portions of the piezoelectric vibrators 20 and 21 as shown by the arrow B. Therefore, a member 33 to be driven which is pressed to the nut 32 is rotated to the direction of the arrow B.

In the stator 26, dead zones which the torsional vibration is not arisen are provided about center portions 18a and 19a of the metal blocks 18 and 19.

In the above embodiment, when the movable contact 16c of the switch 16 is connected to the contact 16a or 16b, the member 22 is rotated to the direction of the arrow A or B in strong torque.

Explaining the drive principle of this embodiment, when the whole length of the metal blocks 18 and 19 and the piezoelectric vibrators 20 and 21 in the stator 26 as shown in Fig.15(a) makes identical with a half wave of the resonance frequency of the longitude vibration due to the longitude vibration of the piezoelectric vibrators 20 and 21 as shown in Fig.15(b) and also, the hole length of the stator 26 between the end face of the nut 32 and the end face of the metal block 19 makes identical with one wave of the resonance frequency of the torsional vibration of the piezoelectric vibrators 20 and 21 as shown in Fig.15(c), strong progressive wave arises on the end portion of the nut 32 and the metal blocks 18 and 29 due to the compound vibration of the longitude vibration and the torsional vibration. Therefore, the member 33 to be driven is pressed on the stator 26 and is rotated strongly.

Referring to Fig.16, in the ultrasonic driving devise of the embodiment according to the above principle, the hole length of the metal blocks 18 and 19 and the piezoelectric vibrators 20 and 21 makes identical with one wave of the longitude vibration, the male screws 24a and 24b of the bolt 24 are put on the dead zones 18a and 19a of the metal blocks 18 and 19 respectively, the divided electrodes 22a and 22b are put between the piezoelectric vibrators 20 and 21 and the electrode 23 is put between the piezoelectric vibrator 21 and the metal block 19. When the alternative current voltage is applied to each of the divided electrodes 22a and 22b, the rotary progression wave arises on the end portions of the metal blocks 18 and 19 and the side portions of the piezoelectric vibrators 20 and 21.

Therefore, when the member 33 to be driven is pressed on the portion in which the torsional vibration arises such as the end portion of the metal block 18 and the alternative current voltage is applied to each of the divided electrodes 22a and 22b, the member 33 is strongly rotated to the direction A or B.

Referring to Fig.17, in a stator of an ultrasonic driving devise of the other embodiment, the bolt 24 is passed through holes of the metal blocks 18 and 19, the piezoelectric vibrators 20 and 21, the divided electrodes 22a and 22b and electrode 23 and the screws of the both end of the bolt 24 are engaged with the nuts 32a and 32b, whereby the stator 26 is composed. The whole length of the metal blocks 18 and 19 and the piezoelectric vibrators 20 and 21 makes identical with one wave of the resonance frequency of the longitude vibration.

In the stator in this embodiment, the progressive wave arises on the end and side portions of the metal blocks 18 and 19, the side portions of the piezoelectric vibrators 20 and 21 and the end and side portions of the nuts 32a and 32b, and the member to be driven is rotated to reversible direction by applying the alternative current voltage to the divided electrode 22a or 22b.

Referring to Fig.18, 16 designates a switch, 17; an alternative current supply, 18 and 19; metal

blocks, 23: an electrode, 24; a bolt, 32; a nut, and 33: a member to be driven. and these elements are same as those of the ultrasonic driving devise in Fig.13. In this embodiment, piezoelectric vibrators 20 and 21 are respectively divided in two as shown by 20a, 20b, 21a and 21b in Fig.19 and an electrode is divided in two by 22a and 22b.

In this ultrasonic driving devise, the reversible progressive wave due to the torsional vibration arises on the end and side portions of the stator 26 by connecting the movable contact 16a to the contact point 16a or 16b.

In Fig.20, a plurality of balls 34 carried with a rotary disk 35 are put on the stator 26 as shown in Fig.13 or Fig.18, a rotary axis is provided with an arm 36 attached to the side of the disk 35 and the balls 34 are pressed by a supporting disk 38. A bolt 39 is passed through the holes of a spring washer 40 and the bolt 24 is engaged with a nut 41 and the disk 38 is fixed on the nut 32 by nut 41.

In this embodiment, the balls 34 are rotated by the progressive wave on the end portion of the metal block 18, whereby the rotary disk 35 is rotated to a reverse direction by applying the alternative current voltage to the divided electrode 22a or 22b and the rotary axis 37 is rotated to the reverse direction. Therefore, this ultrasonic driving devise can be used as an electric motor.

In the embodiment of Fig.21, a rotary axis 37 is fixed with a rotary disk 35 supporting a plurality balls 34, is passed through the hole of a supporting disk 38 in a case 42 and is supported by a bearing 43 prvided with the end protion of the case 42. The balls 34 are strongly contacted with the stator 26 by a spring 44 which is supported by a cap 44 engaged with the end of the case 42.

In this stator 26, the piezoelectric vibrator 20, the divided electrodes 22a and 22b and the electrode 23 are put between the metal blocks 18 and 19 and are respectively attached with each other by adhesive thing.

In this embodiment, when the alternative current voltage is applied to each of the divided electrodes 22a and 22b, the reverse progression wave arises on the end and side portions of the stator 26 and the rotary disk 35 and the rotary axis 37 are rotated to reverse directions by the progressive wave. Therefore, the ultrasonic driving devise can be used as an electric motor.

In the ultrasonic driving device of the above embodiment, the stator may use that of Fig.7.

Claims

1. An ultrasonic driving device comprising of a stator having two metal blocks, a piezoelectric vibrator or vibrators and two electrodes, one electrode being divided in two at least, which are put between two metal blocks, and a bolt for fixing the metal blocks, the piezoelectric vibrator or vibrators and two electrodes by means of screws of the both sides of the metal blocks, and a member to be driven composed on the end portion or side portion of the stator.

2. An ultrasonic driving device set forth claim 1 wherein whole length of the two metal blocks, the piezoelectric vibrator and vibrators and two electrodes makes identical with one wave of resonance frequency of longitude vibration.

3. An ultrasonic driving device set forth claim 1 wherein the member consists of a plurality of balls, a disk supporting the balls, an arm fixed with the side portion of the disk and a rotary axis fixed with the arm, and the balls are pressed with the end portion of the stator by a supporting disk.

4. An ultrasonic driving device set forth claim 1 wherein the member consists of a plurality of balls, a disk supporting the balls and a rotary axis fixed with the disk and supported by a bearing of a case, and the balls are pressed with a supporting disk by the end portion of the stator inserted into the case and pressed by a spring.

5. An ultrasonic driving device set forth claim 1 wherein a piezoelectric vibrator or vibrators are divided in two.

6. An ultrasonic driving device comprising of a stator having two metal blocks, a piezoelectric vibrator or vibrators and two electrodes, one electrode being divided in two at least, which are put between two metal blocks, and a bolt for fixing the metal blocks, the piezoelectric vibrator or vibrators and two electrodes by means of a nut and a screw of one side of the metal blocks, and a member to be driven composed on the nut or the end or side portion of the stator.

7. An ultrasonic driving device set forth claim 6 wherein whole length of the metal blocks, the piezoelectric vibrator and vibrators and two electrodes makes identical with a half wave of resonance frequency of longitude vibration and whole length of the end surfaces the nut and the one side metal block makes identical with one wave of resonance frequency of torsional vibration.

8. An ultrasonic driving device set forth claim 6 wherein the member consists of a plurality of balls, a disk supporting the balls, an arm fixed with the side portion of the disk and a rotary axis fixed with the arm, and the balls are pressed with the end portion of the stator by a supporting disk.

9. An ultrasonic driving device set forth claim 6 wherein the member consists of a plurality of balls, a disk supporting the balls and a rotary axis fixed with the disk and supported by a bearing of a case.

and the balls are pressed with a supporting disk by the end portion of the stator inserted into the case and pressed by a spring.

10. An ultrasonic driving device set forth claim 6 wherein a piezoelectric vibrator or vibrators are divided in two.

11. An ultrasonic driving device comprising of a stator having two metal blocks, a piezoelectric vibrator or vibrators and two electrodes, one electrode being divided in two at least, which are put between two metal blocks, and a bolt for fixing the metal blocks, the piezoelectric vibrator or vibrators and two electrodes with means of screws of the both sides of the bolt and two nut, and a member to be driven composed on the end portion or side portion of the stator.

12. An ultrasonic driving device set forth claim 11 wherein whole length of the metal blocks, the piezoelectric vibrator and vibrators and two electrodes makes identical with a half wave of resonance frequency of longitude vibration and whole length between the end surfaces the two nut makes identical with one wave of resonance frequency of torsional vibration.

13. An ultrasonic driving device set forth claim 11 wherein the member consists of a plurality of balls, a disk supporting the balls, an arm fixed with the side portion of the disk and a rotary axis fixed with the arm, and the balls are pressed with the end portion of the stator by a supporting disk.

14. An ultrasonic driving device set forth claim 11 wherein the member consists of a plurality of balls, a disk supporting the balls and a rotary axis fixed with the disk and supported by a bearing of a case, and the balls are pressed with a supporting disk by the end portion of the stator inserted into the case and pressed by a spring.

15. An ultrasonic driving device set forth claim 11 wherein a piezoelectric vibrator or vibrators are divided in two.

16. An ultrasonic driving device comprising of a stator having two metal blocks, a piezoelectric vibrator or vibrators and two electrodes, one electrode being divided in two at least, which are put between two metal blocks, and a bolt for fixing the metal blocks, the piezoelectric vibrator or vibrators and two electrodes by means of a nut and a screw of one side of the metal blocks, a member to be driven consisting of a plurality of balls, a disk supporting the balls, an arm fixed with the side portion of the disk and a rotary axis fixed with the arm, and a supporting disk fixed on the end portion of the nut by means of a small bolt and a nut, the balls of the member being pressed with the end portion of the stator by the supporting disk.

17. An ultrasonic driving device comprising a case a stator having two metal blocks, a piezoelectric vibrator or vibrators and two electrodes, one electrode being divided in two at least, which are put between two metal blocks, and a bolt for fixing the metal blocks, the piezoelectric vibrator or vibrators and two electrodes by means of screws of the both sides of the metal blocks, and a member to be driven consisting of a plurality of balls, a disk supporting the balls and a rotary axis fixed with the disk and supported by a bearing of the case, the balls being pressed with a supporting disk by the end portion of the stator inserted into the case and pressed by a spring.

18. An ultrasonic driving device comprising a case, a stator having two metal blocks, a piezoelectric vibrator or vibrators and two electrodes, one electrode being divided in two at least, which are put between two metal blocks, the metal blocks, the piezoelectric vibrator or vibrators and two electrodes being fixed by means of adhesive thing, and a member to be driven consisting of a plurality of balls, a disk supporting the balls and a rotary axis fixed with the disk and supported by a bearing of the case, the balls being pressed with a supporting disk by the end portion of the stator inserted into the case and pressed by a spring.

Fig. 1 Prior Art

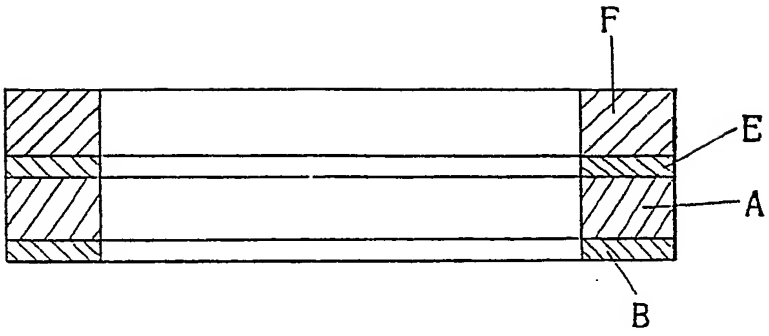


Fig. 2 Prior Art

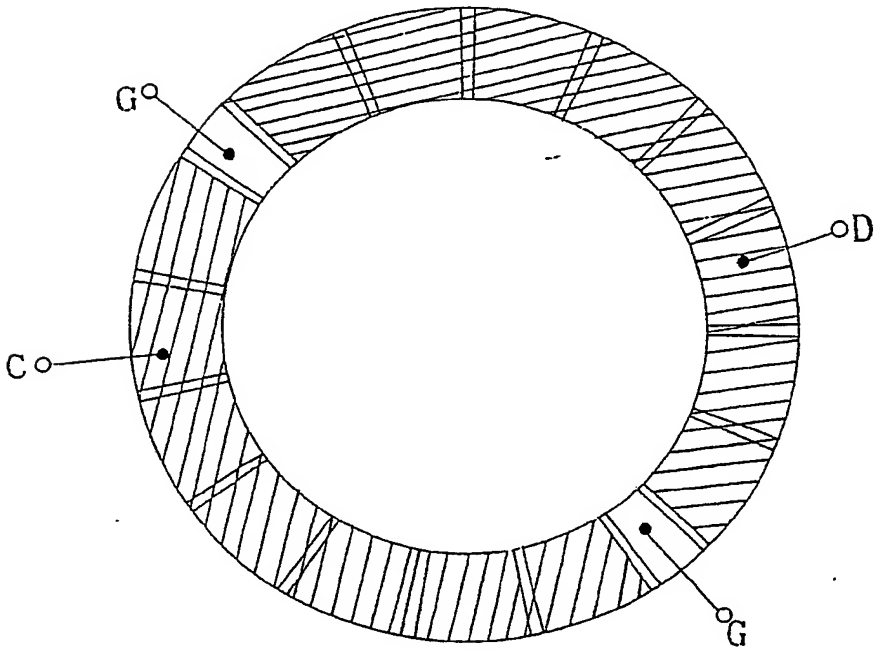


Fig. 3

Prior Art

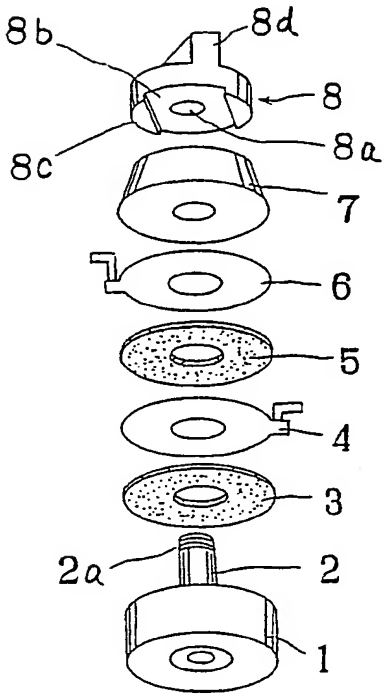


Fig. 4

Prior Art

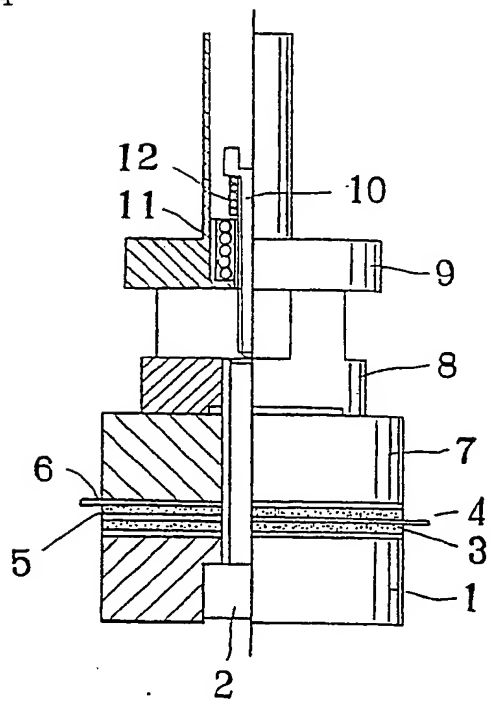


Fig. 5

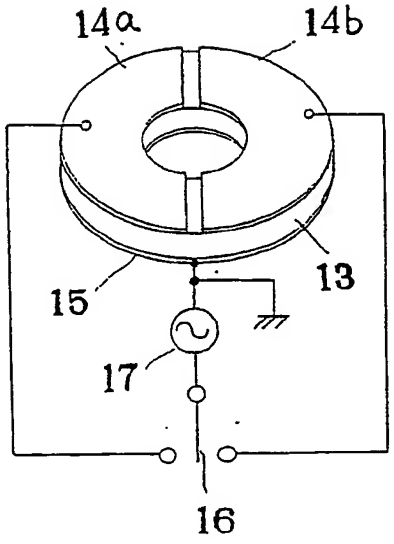


Fig. 6

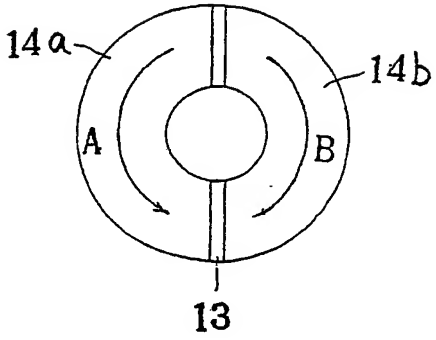


Fig. 7

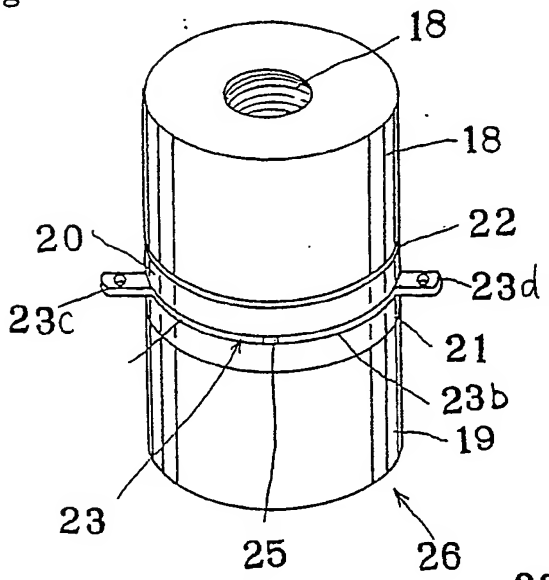


Fig. 8

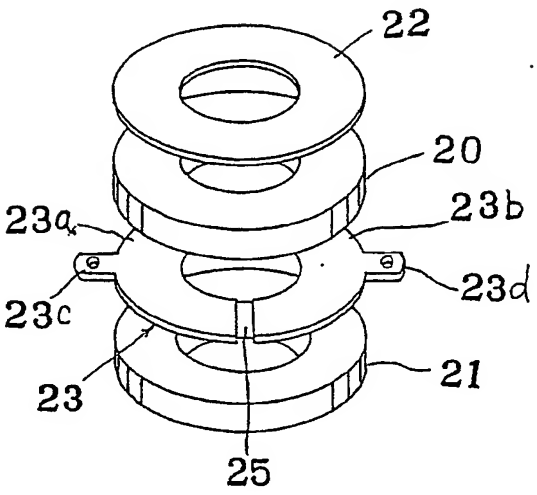


Fig. 9

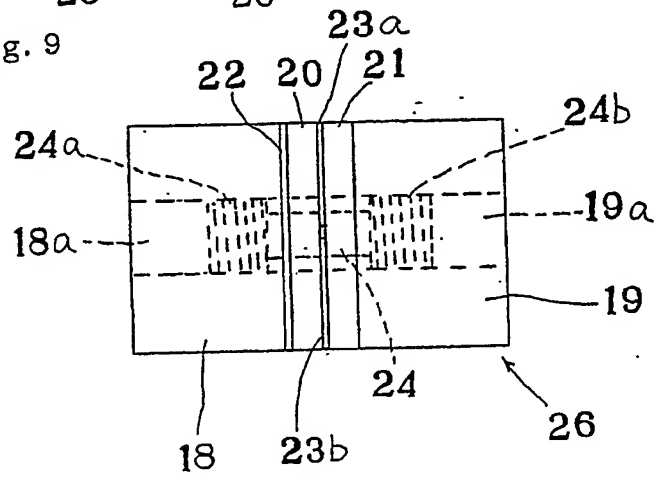


Fig. 10

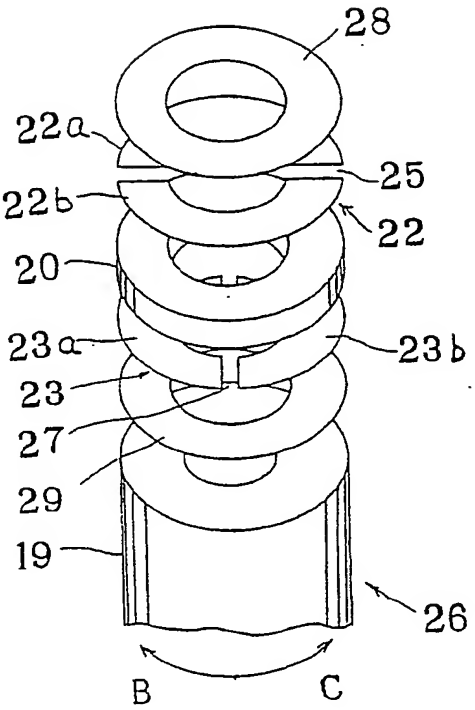


Fig. 12

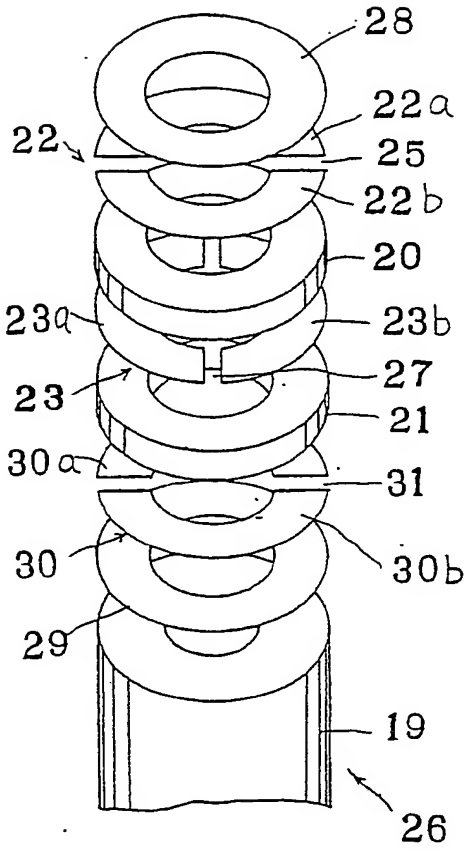


Fig. 11

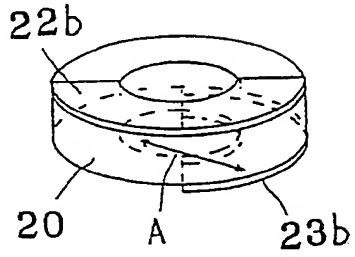


Fig. 13

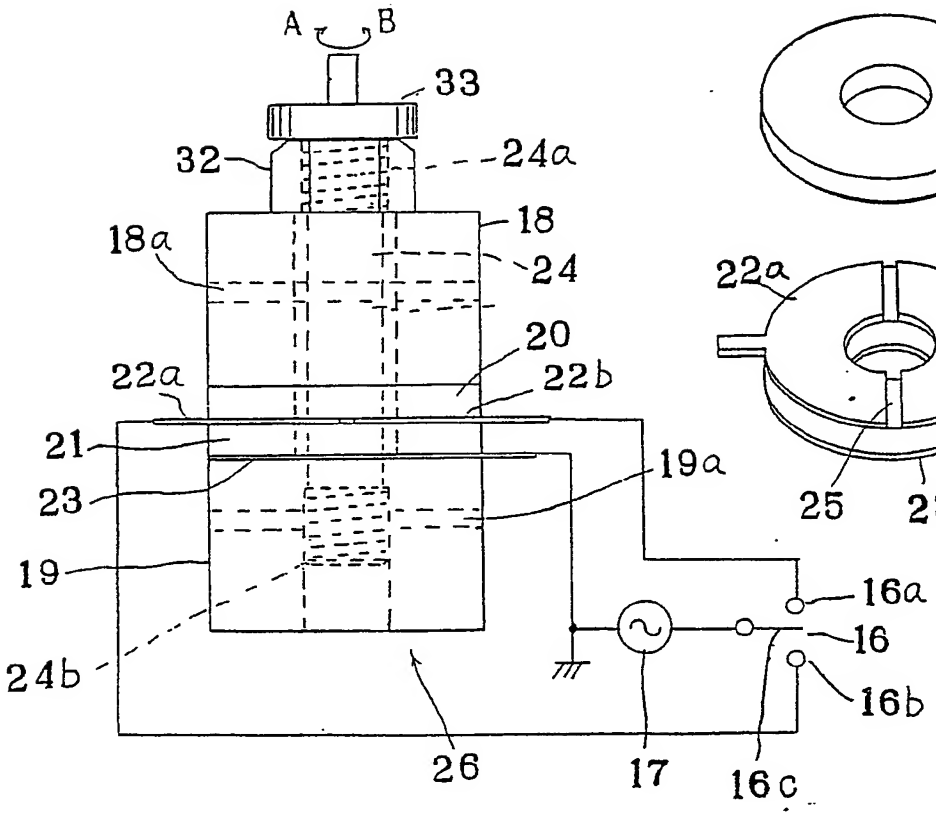


Fig. 14

Fig. 15

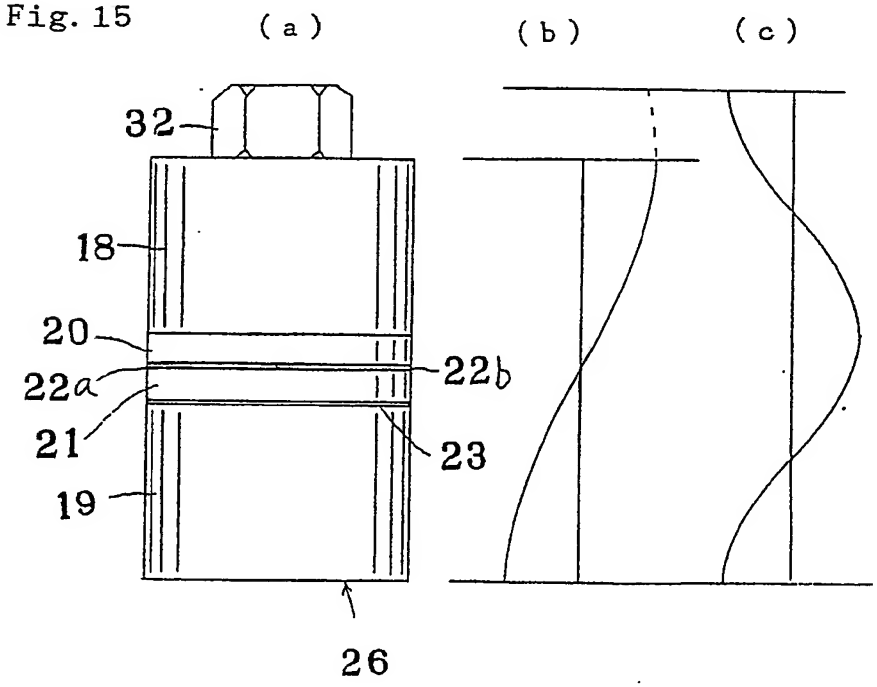


Fig. 16

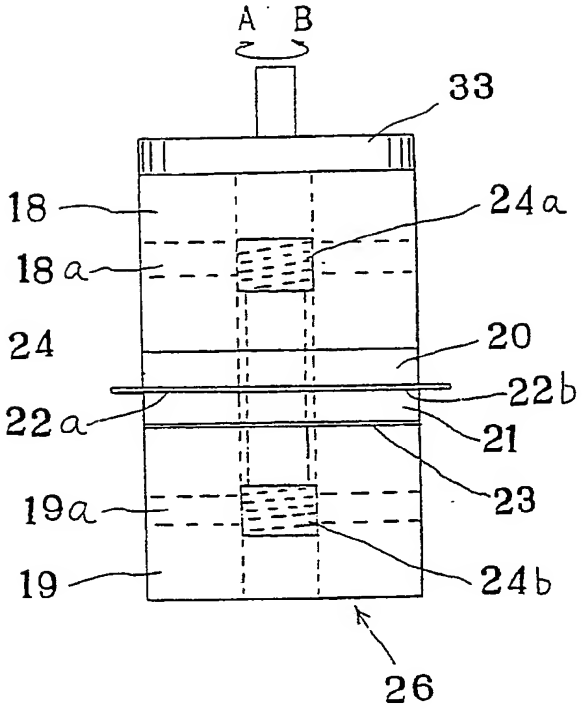


Fig. 17

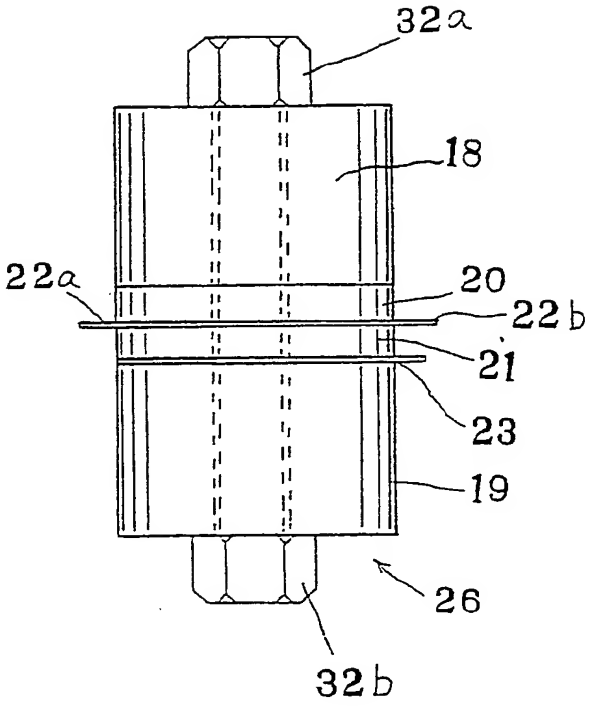


Fig. 18

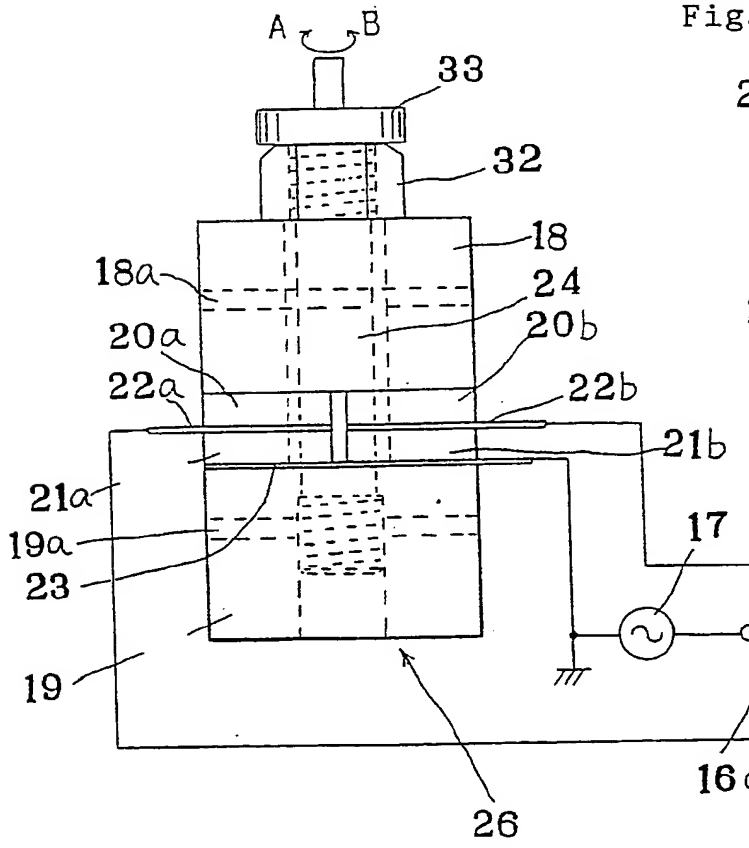


Fig. 19

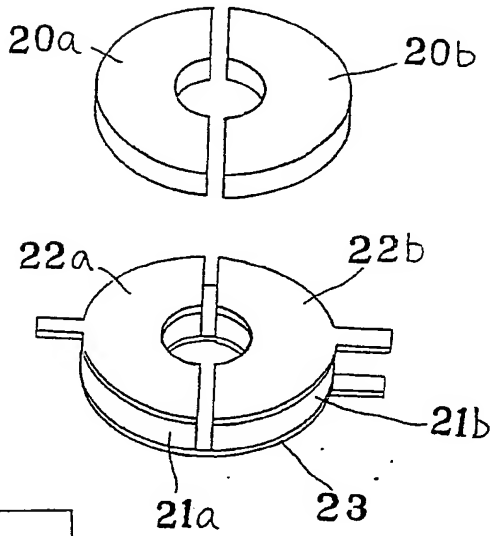


Fig. 20

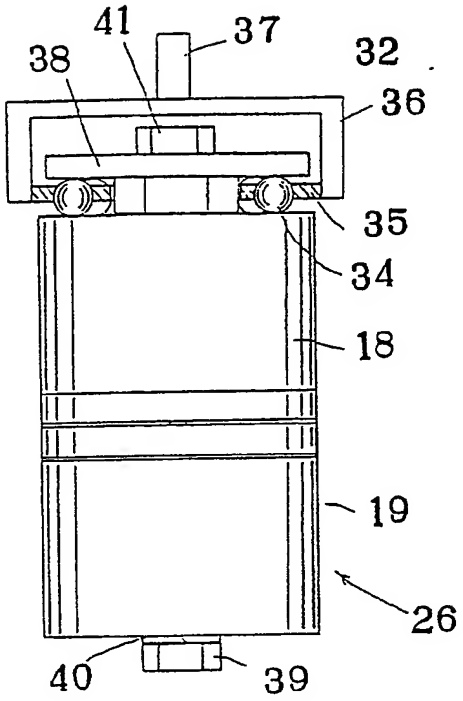

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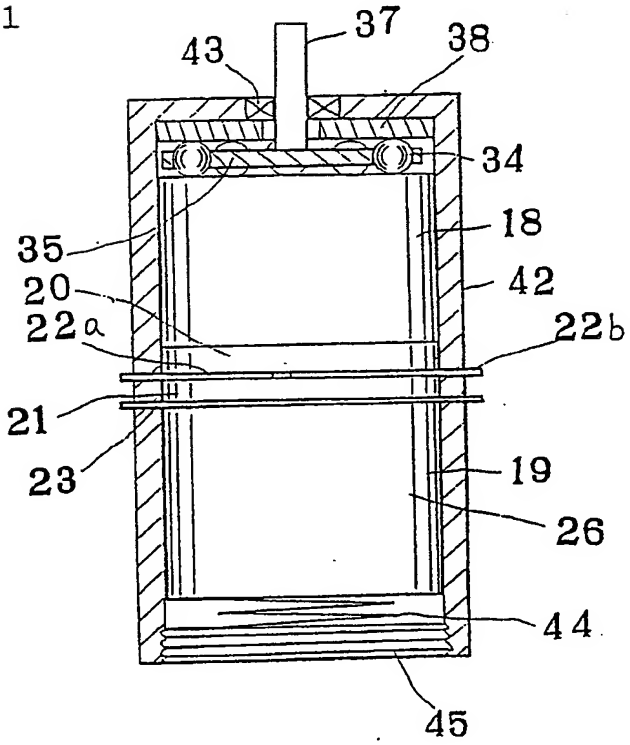
Fig. 21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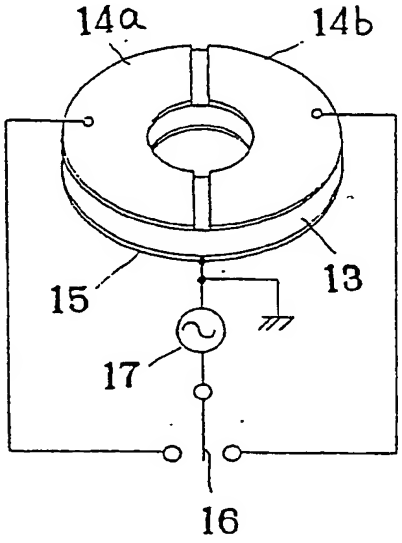
(54) An ultrasonic driving device.

(57) A stator is composed by two metal blocks, a piezoelectric vibrator (13) and vibrators, and two electrodes (14, 15), in which one electrode is divided in two (14a, 14b) at least, the metal blocks, the piezoelectric vibrator or vibrators and two electrodes are fixed by means of a bolt or means of adhesive thing, and a member to be driven composed on the nut or the end or side portion of the stator.

Fig. 5



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EUROPEAN SEARCH REPORT

Application Number

EP 88 11 1072

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl.4)
A	EP-A-0 198 183 (HITACHI MAXELL LTD) * @Page 8, line 21 - page 13, line 9; figures 1-6 *	1,6,11, 16-18	H 01 L 41/08
A	US-A-4 645 964 (HIRAMATSU et al.) * Column 3, line 46 - column 4, line 26; figures 6,7 *	1,6,11, 16-18	
A	US-A-4 652 786 (MISHIRO) * The whole document *	1,6,11, 16-18	
A	SOVIET INVENTION ILLUSTRATED, Section T, week 8414, 16th May 1984, Derwent Publications Ltd, London, GB; & SU-A-1 023 455 (KIEV POLY) 15-06-1983 * Class T, page 16, no. 84-086582/14 *	1,6,11, 16-18	
A	PATENT ABSTRACTS OF JAPAN, vol. 11, no. 165 (E-510)[2612], 27th May 1987; & JP-A-61 295 882 (CANON INC.) 26-12-1986 * Abstract; figure *	3,4,8,9 ,12-14, 16-18	

TECHNICAL FIELDS SEARCHED (Int. Cl.4)

H 01 L

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
THE HAGUE	31-10-1989	BAILLET B.J.R.

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